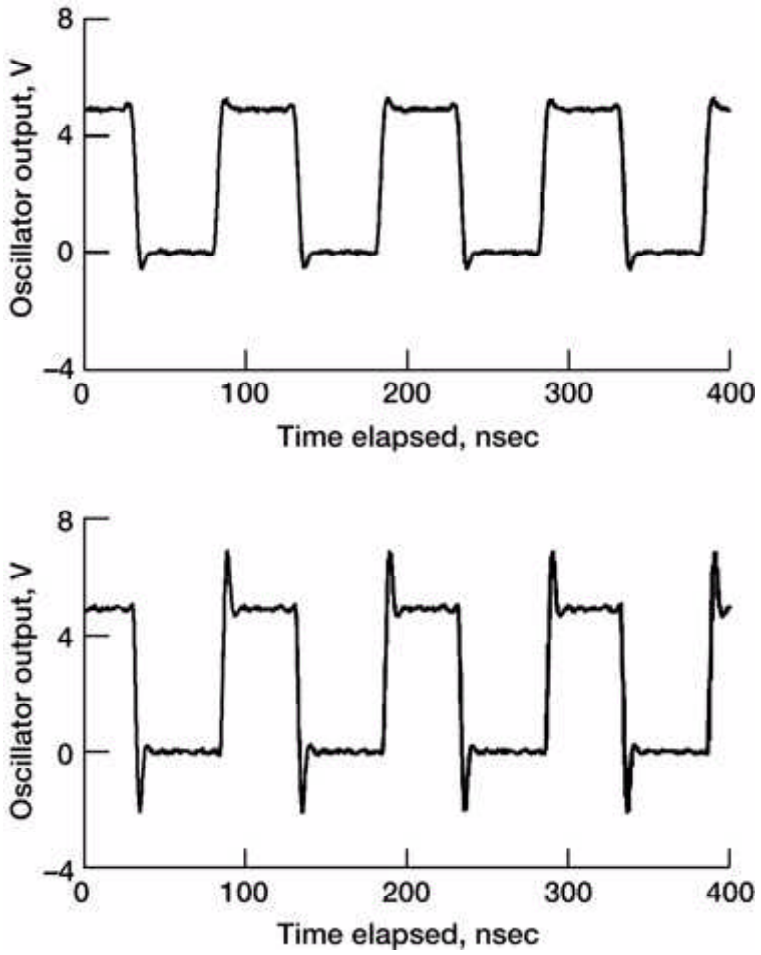
Cryogenic Electronics Being Developed for Space Operation

Planetary exploration missions and deep space probes require electrical power management and control systems that can operate efficiently and reliably in very low temperature environments. Presently, spacecraft operating in the cold environment of deep space carry a large number of radioisotope heating units to maintain the surrounding temperature of the onboard electronics at approximately 20 °C. Electronics capable of operation at cryogenic temperatures would not only tolerate the hostile environment of deep space but also reduce system size and weight by eliminating or reducing the radioisotope heating units and their associate structures. Thereby, such electronics would reduce system development as well as launch costs. In addition, power electronic circuits designed for operation at low temperatures are expected to result in more efficient systems than those at room temperature. This improvement results because semiconductor and dielectric materials have better behavior and tolerance in their electrical and thermal properties at low temperatures.



Output waveforms of an advanced oscillator. Top: Operating temperature, 25 °C.

Bottom: Operating temperature, -196 °C.

The Low Temperature Electronics Program at the NASA Glenn Research Center is focusing on the research and development of electrical components, circuits, and systems suitable for applications in the aerospace environment and in deep space exploration missions. Research is being conducted on devices and systems for reliable use down to cryogenic temperatures. Some of the commercial off-the-shelf as well as developed components that are being characterized include semiconductor switching devices, resistors, magnetics, and capacitors. Semiconductor devices and integrated circuits including digital-to-analog and analog-to-digital converters, dc-dc converters, operational amplifiers, and oscillators are also being investigated for potential use in low-temperature applications. For example, the figure shows the output response of an advanced oscillator at room temperature and at -190 °C. Most oscillators can operate at temperatures down to only -55 °C. It can be seen that, for this oscillator, the low temperature of -196 °C changed the leading and trailing edges of the oscillator pulses by producing overshoot.

The research and development efforts performed under the Low Temperature Electronics Program at Glenn are being carried out through collaboration with other Government agencies, industrial and aerospace companies, and academia. The program supports missions as well as technology development efforts at NASA's Goddard Space Flight Center and Langley Research Center, and the Jet Propulsion Laboratory.

Find out more about this research:
http://www.grc.nasa.gov/WWW/epbranch/ephome.htm

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